126-5-3-10/31

AUTHOR: Vlasov, V. V.

TITLE: Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh) I. On Certain Problems of Electro-Magnetic Defectoscopy of Rails (O nekotorykh voprosakh elektromagnitnoy defektoskopii rel'sov)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1957, Vol 5, Nr 3, pp 442-451 (USSR)

ABSTRACT: In the introduction the author reviews in detail the information hitherto published in the Soviet Union as well as abroad relating to electro-magnetic defectoscopy, mentioning also the advantages and the drawbacks of certain ultrasonics defectoscopes described, for instance, in U.S. and German publications (Refs. 30-31). Summarizing the results of investigations carried out in the Siberian Physico-Technical Institute, A. B. Sapozhnikov (Ref.52) states that the surface magnetic effect for unipolar inductive currents is not very pronounced in the case of railroad rails. Therefore, the conditions of magnetizing rails by means of a stationary and by means of a mobile electro-magnet will be approximately equal. Furthermore, the relatively small intensity of the unipolar inductive

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currents reduces the value of such currents from the point of view of defectoscopy. The author of this paper believes that these conclusions are due to incorrect application of the results of theoretical and experimental work, carried out for weak fields, to the range of relatively strong fields which are applied in defectoscopy of rails. An important problem is increasing the speed of the test apparatus and applying for defectoscopy the eddy currents which are generated in the rails by a mobile source of the magnetic field. Furthermore, there is the problem of separating out the useful signals, since electromagnetic defectoscopes react not only to dangerous defects but also to various harmless rail non-uniformities. In the case of low speeds, this is of little consequence since it is always possible to stop and clarify whether the response was due to a harmless or a dangerous non-uniformity. However, at high speeds the separating out of the useful signals is a very acute problem. The author believes that this can be solved on the basis of the part played by the eddy

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currents, induced in the rails by the mobile source of the magnetic field, in the formation of the field of the defect. From the point of view of practical rail defectoscopy, the author considered it of interest to study the problems of magnetization of such components under travelling conditions, the intensity of the eddy currents generated in the rails, the possibility of applying these eddy currents for defectoscopy purposes and also the problem of separating out useful signals. In the first instance the author investigated the mathematical relations governing the magnetization of the rails under conditions of movement, using the Maxwell equations, Eq.(1), p.447. He arrived at the conclusion that the problem of the density of eddy currents in components during magnetization by a mobile source can be reduced to the solution of an integro-differential equation; he does not deal with the boundary conditions which have to be taken into consideration when solving these equations, Eqs.(9) and (10), p.449. In the second part of this paper published in Vol.VI, Nr 1, 1958, pp 74-82,

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the author deals with the technique of simulating the electro-magnetic phenomena on suitable analogues. The analogy criterion of electromagnetic phenomenon for the case that the source of the d.c. magnetic field and the body magnetised by it are moving relative to each other was formulated for the first time by the author of this paper in his dissertation "Application of the Analogy Theory to the Problem of Rail Defectoscopy" (Sverdlovsk, 1947 and Dokl. Ak. Nauk, 1949, Vol 69, pp 37 etc) The problem of analogy of electromagnetic phenomena under conditions of relative movement were studied in greater detail by I. M. Kirko ("Physical Analogy and Analogy in the Magnetization of Ferromagnetic Bodies" Ac.Sc., Latvia, Riga, 1955). On the basis of the relations derived from these analogy conditions, the authors designed apparatus for simulating under laboratory conditions the phenomena taking place in rails during magnetization by a source moving with a speed of 50 km/hr. The translatory motion was substituted by rotary motion and measures were taken to compensate the dissimilarity caused by the fact that a straight rail was substituted by a curved rail. The rail specimen for the test was

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machined from the tyre of a railway wheel which from the point of view of its chemical composition and method of manufacture was similar to that of rails and was also satisfactory as regards shape, dimensions and uniformity of the material. The outer diameter of the model was 104 cm and the distance between the centres of the poles of the model electromagnet was 12.6 cm. A magnetic shunt was used which in the given case was about 25 times as long as the distance between the poles of the electromagnet. A photo of the equipment is shown in Fig.2 (p. 80 Vol VI, Nr 1, 1958). Acknowledgments are expressed to N. M. Rodigin for his comments.

Card 5/5 There are 63 references, 45 of which are Soviet, 11 English, 1 French, 6 German.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch of the Ac.Sc., USSR)

SUBMITTED: August 21, 1957

1. Tracks (Railroad)--Inspection 2. Tracks (Railroad)--Electromagnetic properties 3. Tracks (Railroad)--Testing equipment

VLASOV, V.V.

Some results of research on electromagnetic defectoscopy of railroad rails. Izv. Sib. otd. AN SSSR no.7:127-131 '58. (MIRA 11:9)

1. Ural'skiy filial AN SSSR.
(Railroads--Rails--Testing) (Magnetic testing)

AUTHOR: Vlasov, V. V. SOV/126-6-1-9/33

TITLE: Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh) 2. Technique of Simulating Electro-Magnetic Phenomena on Models (Metodika modelirovaniya elektromagnitnykh yavleniy)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 1, pp 74-81 (USSR)

ABSTRACT: In the introduction of Part 1 of this paper (same journal, 1957, Vol V, Nr 3, pp 442-451) the author reviews in detail the information hitherto published in the Soviet Union as well as abroad relating to electro-magnetic defectoscopy, mentioning also the advantages and the drawbacks of certain ultrasonics defectoscopes available, for instance, in the U.S.A. and Germany. Summarising the results of investigations carried out in the Siberian Physico-Technical Institute, A. B. Sapozhnikov states that the surface magnetic effect for unipolar inductive currents is not very pronounced in the case of railroad rails. Therefore, the conditions of magnetizing rails by means of

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a stationary and by means of a mobile electro-magnet will be approximately equal. Furthermore, the relatively small intensity of the unipolar inductive currents reduces the value of such currents from the point of view of defectoscopy. The author of this paper believes that these conclusions are due to incorrect application of the results of theoretical and experimental work, carried out for weak fields to the range of relatively strong fields which are applied in defectoscopy of rails. An important problem is increasing the speed of the test apparatus and applying for defectoscopy the eddy currents which are generated in the rails by a mobile source of the magnetic field. Furthermore, there is the problem of separating out the useful signals, since electromagnetic defectoscopes react not only to dangerous defects but also to various harmless rail non-uniformities. In the case of low speeds, this is of little consequence since it is always possible to stop and clarify whether the response

 was due to a harmless or a dangerous non-uniformity.

Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 2. Technique of Simulating Electro-Magnetic Phenomena on Models

However, at high speeds the separating out of the useful signals is a very acute problem. The author believes that this can be solved on the basis of the part played by the eddy currents, induced in the rails by the mobile source of the magnetic field, in the formation of the field of the defect. From the point of view of practical rail defectoscopy, the author considered it of interest to study the problems of magnetization of such components under travelling conditions, the intensity of the eddy currents generated in the rails, the possibility of applying these eddy currents for defectoscopy purposes and also the problem of separating out useful signals. In the first instance the author investigated the mathematical relations governing the magnetization of the rails under conditions of movement, using the Maxwell equations, Eq.(1), p 447. He arrived at the conclusion that the problem of the density of eddy currents in components during magnetization by a mobile source can be reduced to the solution of an integro-differential equation; he does not deal with the

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boundary conditions which have to be taken into consideration when solving these equations, Eqs.(9) and (10), p 449. In the here published second part the author deals with the technique of simulating the electro-magnetic phenomena on suitable analogues. The analogy criterion of electro-magnetic phenomenon for the case that the source of the d.c. magnetic field and the body magnetised by it are moving relative to each other was formulated for the first time by the author of this paper in his dissertation "Application of the Analogy Theory to the Problem of Rail Defectoscopy (Sverdlovsk, 1947 and Dokl. Ak. Nauk, 1949, Vol 69, pp 37 etc). The problem of analogy of electromagnetic phenomena under conditions of relative movement were studied in greater detail by I. M. Kirko ("Physical Analogy and Analogy in the Magnetization of Ferromagnetic Bodies", Ac.Sc., Latvia, Riga, 1955). On the basis of the relations derived from these analogy conditions, the authors designed apparatus for simulating under laboratory conditions the phenomena taking place in rails during magnetization by a

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source moving with a speed of 50 km/hr. The translatory motion was substituted by rotary motion and measures were taken to compensate the dissilimilarity caused by the fact that a straight rail was substituted by a curved rail. The rail specimen for the test was machined from the tyre of a railway wheel which from the point of view of its chemical composition and method of manufacture was similar to that of rails and was also satisfactory as regards shape, dimensions and uniformity of the material. The outer diameter of the model was 104 cm and the distance between the centres of the poles of the model electromagnet was 12.6 cm. A magnetic shunt was used which in the given case was about 25 times as long as the distance between the poles of the electro-magnet. A photo of the equipment is shown in Fig.2, p 80. In this part the author does not consider the problem of applying the results of model tests for the case of magnetization of rails under real conditions of operation. In the model a specific rail type was used, whilst in

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reality rails of various types are encountered differing in dimensions, degree of wear, method of manufacture and the rails may also be affected by the temperature and by seasonal changes. Furthermore, it was found that the rail model heats up during rotation inside a magnetic field. Therefore, in Part 3 of this paper (Vol VI, No 2, pp 247-253) the author analyses in the first approximation the influence of the difference in the rails used under real conditions from those used in models so as to establish the types of rails for which the model results are applicable and also the influence of the relative movement between the source of the magnetic field and the body magnetised by that field. It was found that in the first approximation the experimental data obtained with type IA rail models are applicable to rails of other types used in railway transportation, whereby in the case of differences in the geometry, the magnetic and the electric properties of rails from those of the model, the similarity of the phenomena is achieved by changing the applied limits of

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the speed of movement of the source of the magnetic field. Appropriate relations are derived for evaluating the speed of movement of the source of the magnetic field relative to the rails and some other physical magnitudes from the data of model experiments. It was found that detection of defects by means of the induced eddy currents is more effective for modern heavy type rails than for the older lighter type rails.

Acknowledgments are expressed to N. M. Rodigin for his comments.

There are 2 figures and 41 references, 39 of which are Soviet, 2 English.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch of the Ac.Sc.USSR)

SUBMITTED: August 21, 1957

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1. Tracks (Railroad)--Inspection 2. Electromagnetic fields---Applications 3. Tracks (Railroad)--Model test results

AUTHOR: Vlasov, V. V. SOV/126-6-2-7/34

TITLE: Investigation by Means of Defectoscopy of Railway Rails in Mobile Magnetic Fields (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh)
3. Certain Problems of Evaluation of Experimental Data Obtained in the Case of Simulating on Models the Magnetisation of Rails (Nekotoryye voprosy obrabotki opytnykh dannykh pri modelirovanii namagnichivaniya rel'sov)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 2, pp 247-254 (USSR)

ABSTRACT: In the introduction of Part 1 of this paper (same journal, 1957, Vol V, Nr 3, pp 442-451) the author reviews in detail the information hitherto published in the Soviet Union as well as abroad relating to electro-magnetic defectoscopy, mentioning also the advantages and the drawbacks of certain ultrasonic defectoscopes available, for instance, in the U.S.A. and Germany. Summarising the results of investigations carried out in the Siberian Physico-Technical Institute, A. B. Sapozhnikov states that

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Investigation by Means of Defectoscopy of Railway Rails in Mobile Magnetic Fields. 3. Certain Problems of Evaluation of Experimental Data Obtained in the Case of Simulating on Models of Magnetisation of Rails

the surface magnetic effect for unipolar inductive currents is not very pronounced in the case of railroad rails. Therefore, the conditions of magnetising rails by means of a stationary and by means of a mobile electro-magnet will be approximately equal. Furthermore, the relatively small intensity of the unipolar inductive currents reduces the value of such currents from the point of view of defectoscopy. The author of this paper believes that these conclusions are due to incorrect application of the results of theoretical and experimental work, carried out for weak fields to the range of relatively strong fields which are applied in defectoscopy of rails. An important problem is increasing the speed of the test apparatus and applying for defectoscopy the eddy currents which are generated in the rails by a mobile source of the magnetic field. Furthermore, there is the problem of separating out the useful signals, since electromagnetic defectoscopes react not only to dangerous defects but also

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to various harmless rail non-uniformities. In the case of low speeds, this is of little consequence since it is always possible to stop and clarify whether the response was due to a harmless or a dangerous non-uniformity. However, at high speeds the separating-out of the useful signals is a very acute problem. The author believes that this can be solved on the basis of the part played by the eddy currents, induced in the rails by the mobile source of the magnetic field, in the formation of the field of the defect. From the point of view of practical rail defectoscopy, the author considered it of interest to study the problems of magnetisation of such components under travelling conditions, the intensity of the eddy currents generated in the rails, the possibility of applying these eddy currents for defectoscopy purposes and also the problem of separating out useful signals. In the first instance the author investigated the mathematical relations governing the magnetisation of the rails under conditions

Investigation by Means of Defectoscopy of Railway Rails in Mobile Magnetic Fields. 3. Certain Problems of Evaluation of Experimental Data Obtained in the Case of Simulating on Models of Magnetisation of Rails

of movement, using the Maxwell equations, (Eq.1, p 447 of Part 1). He arrived at the conclusion that the problem of the density of eddy currents in components during magnetisation by a mobile source can be reduced to the solution of an integro-differential equation; he does not deal with the boundary conditions which have to be taken into consideration when solving these equations, Eqs.(9) and (10), p 449 of Part 1. In the second part (same journal, 1958, Vol 6, Nr 1) the author deals with the technique of simulating the electro-magnetic phenomena on suitable analogues. The analogy criterion of electro-magnetic phenomenon for the case that the source of the d.c. magnetic field and the body magnetised by it are moving relative to each other was formulated for the first time by the author of this paper in his dissertation "Application of the Analogy Theory to the Problem of Rail Defectoscopy (Sverdlovsk, 1947 and Dokl. Ak. Nauk, 1949, Vol 69, pp 37 etc). The problem of analogy of electro-

 magnetic phenomena under conditions of relative movement

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were studied in greater detail by I. M. Kirko ("Physical Analogy and Analogy in the Magnetisation of Ferromagnetic Bodies", Ac.Sc., Latvia, Riga, 1955). On the basis of the relations derived from these analogy conditions, the authors designed apparatus for simulating under laboratory conditions the phenomena taking place in rails during magnetisation by a source moving with a speed of 50 km/hr. The translatory motion was substituted by rotary motion and measures were taken to compensate the dissimilarity caused by the fact that a straight rail was substituted by a curved rail. The rail specimen for the test was machined from the tyre of a railway wheel which from the point of view of its chemical composition and method of manufacture was similar to that of rails and was also satisfactory as regards shape, dimensions and uniformity of the material. The outer diameter of the model was 104 cm and the distance between the centres of the poles of the model electromagnet was 12.6 cm. A magnetic shunt

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was used which in the given case was about 25 times as long as the distance between the poles of the electromagnet. A photo of the equipment is shown in Fig.2, p 80 of Part 2. In this part the author does not consider the problem of applying the results of model tests for the case of magnetisation of rails under real conditions of operation. In the model a specific rail type was used, whilst in reality rails of various types are encountered differing in dimensions, degree of wear, method of manufacture; and the rails may also be affected by the temperature and by seasonal changes. Furthermore, it was found that the rail model heats up during rotation inside a magnetic field. Therefore, in the here published third part the author analyses in the first approximation the influence of the difference in the rails used under real conditions from those used in models so as to establish the types of rails for which the model results are

 applicable and also the influence of the relative movement

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between the source of the magnetic field and the body magnetised by that field. It was found that in the first approximation the experimental data obtained with type IA rail models are applicable to rails of other types used in railway transportation, whereby in the case of differences in the geometry, the magnetic and the electric properties of rails from those of the model, the similarity of the phenomena is achieved by changing the applied limits of the speed of movement of the source of the magnetic field. Appropriate relations are derived for evaluating the speed of movement of the source of the magnetic field relative to the rails and some other physical magnitudes from the data of model experiments. It was found that detection of defects by means of the induced eddy currents is more effective for modern heavy type rails than for the older lighter type rails.

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Investigation by Means of Defectoscopy of Railway Rails in Mobile Magnetic Fields. 3. Certain Problems of Evaluation of Experimental Data Obtained in the Case of Simulating on Models of Magnetisation of Rails

There are 3 figures, 2 tables and 10 references, 9 of which are Soviet, 1 English.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch of the Ac.Sc., USSR)

SUBMITTED: August 24, 1957

Card 8/8 1. Tracks (Railroads)--Inspection 2. Magnetic fields--Applications

AUTHOR: Vlasov, V. V. SOV/126-6-3-6/32

TITLE: Defectoscopy Studies on Railroad Rails in Moving Magnetic Fields (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh). 4. Study of the Eddy Currents Induced in Rails from their Reaction on the Primary Field (Izucheniye vikhrevykh tokov, navodimykh v rel'se po reaktsii ikh na pervichnoye pole)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 3, pp 426-433 (USSR)

ABSTRACT: In Part I of this paper (1957, Vol 5, Nr 3, pp 442-451) hitherto published information was reviewed and a mathematical analysis of the problem was presented. In the second part (1958, Vol 6, Nr 1, pp 74-82) the straight rail was substituted by a circular strip of similar metal. In Part III (1958, Vol 6, Nr 2, pp 247-254) the author analysed in the first approximation the influence of the differences in the rail analogue used in the model from rails operating under real conditions and he arrived at the conclusion that detection of defects by induced eddy currents is more effective in the case of modern heavy type rails than in the case of older

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Defectoscopy Studies on Railroad Rails in Moving Magnetic Fields
4. Study of the Eddy Currents Induced in Rails from their Reaction on the Primary Field

lighter rails. In this fourth part of the paper the author studies the eddy currents in the rail on the basis of the reaction of this current in the primary magnetic field. The investigation consisted of measuring the longitudinal and the transverse components of the resulting field at the side surface of the rail model in the region of the leading pole of the electro-magnet. The relative location of the electro-magnet, the part of the circular model of the rail and of the coordinate system are shown in Fig.1. The field was measured ballistically by ejecting a small flat coil from the side surface of the rail model beyond the limits of the field. The coil constant was 130 turns·cm^2 and the area of contact with the surface of the rail analogue was 1 cm^2. The experiments were effected with the electro-magnet described in the earlier part of the paper under the following conditions: the distance between each of the pole ends and the surface of the rail model was 5 mm, the

 MMF was 6600 ampere turns, the speed of movement of the

rail model relative to the electro-magnet was 500 r.p.m. These data relate to the case of magnetising the rail by similar electro-magnets with distances between the pole ends of the electro-magnet and the rail equalling 17.5 mm, an MMF of 23 000 ampere turns and a speed of movement of the electro-magnet of 25 km/hr. The reactions of the eddy currents on the primary magnetic field were measured by measuring the induction in the core of the model by means of a ballistic method using switching of the current in the electro-magnet in presence and in absence of movement of the model. The speed of movement was such as to correspond to a speed of 45 km/hr on the rails. The results of measurements of the induction in the core of the electro-magnet are entered in the graph, Fig 6, and it can be seen that the induction in the core during movement is less than in the absence of movement, due to the eddy currents induced in the rails. The induction in the air gap was also measured by a ballistic method and the results are graphed in Fig 7; it can be seen from this

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4. Study of the Eddy Currents Induced in Rails from their Reaction on the Primary Field

graph that, even at a low speed of movement and at a relatively low external MMF, the distribution of the induction in the air gap differs considerably from that pertaining to static conditions. An approximate calculation is also made of the level of the eddy currents induced in the rails. The author summarises his conclusions thus: it is shown that the magnetic field in the neighbourhood of the side surface of the rail head will increase appreciably in the case of moving electro-magnet as compared to a static field even if the speed is only 25 km/hr and the MMF is 23 ampere turns; The most intensive increase will be observed for the longitudinal field component under the pole and in the region adjacent to the inter-pole space of the electro-magnet, which indicates that relatively intensive, predominantly transverse currents are generated under these sections of the pole. It was established that, as a result of the motion, the induction in the core of the electro-magnet decreases and in the air gap between the poles and at the

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4. Study of the Eddy Currents Induced in Rails from their
Reaction on the Primary Field

rail surface a considerable redistribution takes place, the induction decreasing under the frontal and increasing under the rear edges of the poles. An approximate evaluation is given of the order of magnitude of the current in the rail according to which in a type I-A rail it amounts to about 90 A/cm for a speed of movement of the magnetic field of 45 km/hr and an external MMF of 24 000 ampere turns.
There are 7 figures and 8 references, 7 of which are Soviet, 1 German.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR
(Institute of Metal Physics, Ural Branch of the Ac.Sc, USSR)

SUBMITTED: September 11, 1957

1. Tracks (Railroad)--Inspection equipment 2. Tracks (Railroad)
--Magnetic factors 3. Tracks (Railroad)--Model test results
4. Electric currents--Applications 5. Electromagnets--Applications

SOV/126-6-4-8/34

AUTHOR: Vlasov, V.V.

TITLE: Investigation Relating to the Defectoscopy of Railroad Rails in Mobile Magnetic Fields. Part 5. Study of the Eddy Currents Induced in the Head of a Rail by Means of an Electric Field at its Surface (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh. 5. Izucheniye vikhrevykh tokov, navodimykh v golovke rel'sa po elektricheskomu polyu na poverkhnosti yeye)

PERIODICAL: Fizika metallov i metallovedeniye, 1958, Vol 6, Nr 4, pp 628-632 (USSR)

ABSTRACT: Part 1 of this paper was published in Fizika metallov i metallovedeniye, Vol 5, Nr 3, 1957, pp 442-451; Part 2 in Vol 6, Nr 1, 1958, pp 74-81; Part 3 in Vol 6, Nr 2, 1958, pp 247-254; Part 4 in Vol 6, Nr 3, 1958, pp 426-432. For the purpose of detecting transverse cracks in railheads by means of eddy currents induced in them by a mobile source of a field, the longitudinal component of the current is of considerable importance. The current density in the railhead and at the joint

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Investigation Relating to the Defectoscopy of Railroad Rails in Mobile Magnetic Fields. Part 5. Study of the Eddy Currents Induced in the Head of a Rail by Means of an Electric Field at its Surface

between the head and the neck was evaluated by K.M.Polivanov (Ref.1) in the case of magnetisation with a relatively weak transverse field moving at a high speed. As far as the author is aware, no similar investigations have been made for the case of magnetisation with a relatively strong field. He considered it of interest to evaluate, at least by means of a rough approximation, the longitudinal component of the current density in the railhead in the case of magnetisation under such conditions with a strong magnetic field. In this paper experiments are described which were carried out for studying the longitudinal component of the electric field potential at the side surface of a railhead by simulating on models, as described in Parts 1 and 2 of this work (Ref.2 and 3). On the basis of these investigations an approximate evaluation is given of the longitudinal component of

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the current density in the railhead. A sketch of the metering arrangement is shown in Fig.1. The obtained results are graphed in Fig.2-5. It was established that it is possible to evaluate approximately the longitudinal relative speed of the component of the current densities induced in parts which are moving inside a magnetic field on the basis of the components of the electric field potential. It is shown that the longitudinal component of the electric field potential at the side surface of the railhead, and thus also the respective component of the current density in the railhead, is identical to the respective component of the current density in the railhead within the area of the inter-pole space of the electromagnet. A relation has been derived for the dependence on the speed of movement of the potential of the electric field for the railhead section located in the centre between the poles of the electromagnet. An approximate evaluation is

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given of the longitudinal component of the density of eddy currents in the railhead for a particular case, whereby the current density in the section of the railhead located in the centre between the poles of an electromagnet is large enough for detecting defects. There are 5 figures and 5 references all of which are Soviet.

ASSOCIATION: Institut Fiziki Metallov Ural'skogo Filiala AN SSSR (Institute of Metal Physics, Ural Branch of the AS USSR)

SUBMITTED: 11th September 1957.

SOV/126-6-5-5/43

AUTHOR: Vlasov, V. V.

TITLE: Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh)
6. Investigation of the Magnetic Flux in the Railhead (Izucheniye magnitnogo potoka v golovke rel'sa)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1958, Vol 6, Nr 5, pp 794-803 (USSR)

ABSTRACT: This is part of a long study by the author of the problem of detecting defects in rails by means of magnetic fields generated from a magnet moving along the rails.
Parts 1 to 5 were published in various earlier issues. Part 7 "Approximate evaluation of the surface effect in the railhead" is published in Vol 6, Nr 6, of this journal, pp 1006-1010. Part 8, Vol 7, 1959, Nr 1, pp 159-160, deals with the topography of the eddy currents in the railhead, Parts 9 and 10, Vol 7, Nr 2, pp 186-191 and 319-320 deal respectively with the role of eddy currents in the formation of the field of a defect and the study of the magnetic flux in the railhead for various dimensions of the air gap in the magnetic

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Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 6. Investigation of the Magnetic Flux in the Railhead

circuit.

K. M. Polivanov (Ref 1) investigated the distribution of the magnetic flux in a type 1-A rail which is magnetized by a transverse field, the source of which moves at a low velocity. The author of this paper considered it of interest to study the magnetic flux in the railhead under conditions of "longitudinal" magnetization by means of a relatively strong field which moves at a high velocity relative to the rail. Studies are described of the magnetic flux in the railhead carried out by means of model investigations of the process of magnetization of the rail by a moving field source. The magnetic flux in the model of a rail can be investigated relatively simply by means of a coil which surrounds a part of the rail and moves together with the rail relative to the field. The nature of the magnetization of rails and of the model are investigated, with particular reference to the longitudinal component of the magnetic flux. The

Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Rails. 6. Investigation of the Magnetic Flux in the Railhead

magnetic flux during the experiment manifested itself in the form of an e.m.f., the schematic diagram of which is given in Fig 1B. This emf is a derivative according to time of the magnetic flux curve (Fig 1 6). In order to obtain the flux curve it is necessary to apply integration which has been done by means of an integration-amplification circuit shown in Fig 4, p 798. The results of qualitative and quantitative investigations of the flux in the railhead are given and discussed. The author arrives at the following conclusions. Under otherwise equal conditions magnetization of rails by a mobile field differs considerably from magnetization by a stationary source of the field. The character of the changes of the magnetic field in the railheads as a function of time depends on the shape and the magnitude of the pole-shoes of the electromagnet. The longitudinal component of the magnetic flux in a type 1-A railhead was studied in the case of its magnetization by means of an electromagnet with pole-shoes which have a flat surface

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on the rail side. The longitudinal component of the flux in the section of the rail located in the centre of the space between the poles of the electromagnet decreases with increasing speed and this decrease will be the more pronounced the higher the intensity of the external field. With increasing displacement of a section of the railhead from the first pole of the electromagnet to the second in the direction of movement, the eddy currents in the railhead become attenuated. The results have the important practical consequence that in the case of inspection of components which are in movement it is not advisable to apply intensive external fields. There are 10 figures and 19 references, 17 of which are Soviet, 2 English.

ASSOCIATION: Institut fiziki metallov Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch, Ac.Sc. USSR)

SUBMITTED: October 31, 1957

SOV/126-6-6-6/2

AUTHOR: Vlasov, V. V.

TITLE: Investigations Relating to Defectoscopy of Railroad Rails Inside a Moving Magnetic Field. Part 7. Approximate Evaluation of the Surface Effect in the Rail Head (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh. 7. Priblizhennaya otsenka poverkhnostnogo effekta v golovke rel'sa)

PERIODICAL: Fizika metallov i metallovedeniye, 1958, Vol 6, Nr 6, pp 1006-1010 (USSR)

ABSTRACT: This is part of a long study by the author of the problem of detecting defects in rails by means of magnetic fields generated from a magnet moving along the rails. Parts 1 to 6 were published in various earlier issues. Part 8, 1959, Vol 7, Nr 1, pp 159-160, deals with the topography of the eddy currents in the railhead, Parts 9 and 10, 1959, Vol 7, Nr 2, pp 186-191, and 319-320, deal respectively with the role of eddy currents in the formation of the field of a defect and the study of the magnetic flux in the railhead for various dimensions of the air gap in the magnetic circ Magnetization of the rail head by means of a mobile local field is accompanied by an appreciable surface effect (Re The quantitative evaluation of this effect is of conside

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Investigations Relating to Defectoscopy of Railroad Rails Inside a Moving Magnetic Field. Part 7. Approximate Evaluation of the Surface Effect in the Rail Head.

importance for the defectoscopy of rails under conditions of relative movement. The author considered it of interest to evaluate the surface effect in rails during their magnetization by means of a mobile field source. A rail can be considered as consisting of a cylinder and of two plates. As far as the author is aware, the surface effect in such bodies during their magnetization with a mobile field has, so far, not been investigated. Due to the complexity of the problem, the author limits himself to an approximate evaluation of the depth of penetration of the mobile local magnetic field in the rail head, which is based on experimental data on the magnetic flux in the rail head (Ref.1). It is assumed that the entire magnetic flux is concentrated in the rail head at a certain depth whilst its central part remains practically non-magnetized. This condition corresponds to the relatively frequently applied assumption that the induction in the body propagates in the form of a steep front when the field reache

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Investigations Relating to Defectoscopy of Railroad Rails Inside a Moving Magnetic Field. Part 7. Approximate Evaluation of the Surface Effect in the Rail Head.

a certain critical value, which is near to the coercive force. The distance within which the induction remains constant obviously represents the depth of the magnetized layer, which is also assumed as being the depth of penetration of the field; this is permissible since the author considers magnetization in fields which exceed very considerably the coercive force. To simplify the investigation the rail head is substituted by a cylinder with an equal cross-section and the magnetization of the cylinder will be considered in a longitudinal field, disregarding the transverse component. Thus, an approximate evaluation is made of the depth of penetration of the magnetic field into the rail head (of the Soviet type 1-A rails) in the case of "longitudinal" magnetization of the rail by means of a field of a mobile electromagnet of a certain type, as a function of the speed of movement of the electromagnet with various ampere-turn values. It was found that penetration of the magnetic field is accompanied by a clearly pronounced surface effect even at a relatively low speed of movement for magnitudes of magnetizing fields which are currently used in defectoscopy work. It was also found that the depth of pene-

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tration of the field depends not only on the speed of movement but also on the magnitude of the external field whereby the depth of penetration will increase somewhat with a decrease in the magnetization field. The author provides a qualitative explanation of this feature in the given case. The practical consequence of the derived conclusions is that no attempt should be made to utilise relatively strong magnetic fields for defectoscopy studies of components under conditions of relative movement of the magnetic field. There are 2 figures and 15 references, 14 Soviet and 1 English.

ASSOCIATION: Institut fiziki metallov, Ural'skogo filiala AN SSSR (Institute of Metal Physics, Ural Branch, Academy of Sciences, USSR)

SUBMITTED: October 31, 1957.

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24(3) SOV/139-59-1-34/34

AUTHOR: Vlasov, V.V.

TITLE: On B.F. Kononkov's paper "Eddy Currents in Massive Bodies Moving in a Constant Magnetic Field of Concentrated Sources" (Po povodu stat'i B.F. Kononkova "Vikhrevyye toki v massivnykh telakh dvizhushchikhsya v postoyannom magnitnom pole sosredotochennykh istochnikov")

PERIODICAL: Izvestiya Vysshikh Uchebnykh Zavedeniy, Fizika, 1959, Nr 1, pp 174-175 (USSR)

ABSTRACT: Kononkov's paper (Ref 1) is alleged to contain a number of inaccuracies. The main mistake consists in the following. Kononkov assumed that the eddy current density is proportional to the electric field when the ferromagnetic body moves in a magnetic field. In fact this proportionality occurs only in one special case (Ref 10). As a matter of fact the density of eddy currents in a body moving relative to a source of a magnetic field is given by:

$$\underline{\delta} = \gamma (\underline{E} + \underline{v} \times \underline{B})$$

where $\underline{\delta}$ is the current density, γ is the electrical conductivity, $\underline{E}$ is the electric field, $\underline{v}$ is the

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SOV/139-59-1-34/34

On B.F. Kononkov's paper "Eddy Currents in Massive Bodies Moving in a Constant Magnetic Field of Concentrated Sources"

velocity of the body relative to the field and $\underline{B}$ is the magnetic induction. Thus the relation $\underline{\delta} = \gamma\underline{E}$ will only hold in the direction of motion in which case $\underline{v} \times \underline{B} = 0$. There are 10 references, of which 2 are English and 8 Soviet.

ASSOCIATION: Institut Fiziki Metallov AN SSSR (Institute of Physics and Metals, Academy of Sciences of the USSR).

SUBMITTED: December 7, 1958

USCOMM-DC-60,945

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AUTHOR: Vlasov, V. V. SOV/126-7-1-28/28

TITLE: Investigations Relating to Defectoscopy of Railroad Rails in Mobile Magnetic Fields. Part 8. Approximate Scheme of the Eddy Currents in the Railhead (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh. 8. Primernaya skhema vikhrevykh tokov v golovke rel'sa)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1959, Vol 7, Nr 1, pp 159-160 (USSR)

ABSTRACT: Part 9 of this paper is published in the 1959, Nr 2 issue on pp 186-191 "On the role of eddy currents in the formation of the field produced by a defect". Part 10 is published in the 1959, Nr 2 issue on pp 319-320 "Study of the magnetic flux in the railhead in the case of differing air gaps in the magnetic circuit".
If defects in rails are to be detected by means of eddy currents induced in them by the magnetic field, it is necessary to have some idea of the topography of these currents. For instance, the possibility of detecting defects of one type or another will depend on the direction of the eddy currents. For instance, it can be anticipated that cracks located in a direction perpendicular to the

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lines of the current flow would be detected more effectively than cracks at other angles relative to this flow and that it will not be possible to detect such cracks if the lines of the current flow are tangential to the wall of the cracks. The topography of eddy currents in rails depends on the method of magnetising them. So far, it has not been possible to compile a detailed topographical scheme of eddy currents in a rail magnetised "longitudinally" by a mobile field of a d.c. fed Π-shaped electromagnet. However, on the basis of results published in earlier parts of this paper (Refs 1-3), it is possible to present for the given case an approximate scheme of eddy currents in the railhead and the description of this scheme is the subject of this paper. The eddy currents developing in the railhead can be imagined as being formed as a result of superposition of separate excitations caused by the longitudinal and the transverse components of the current.

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These are produced by the respective components of the magnetic flux. These fluxes and the eddy current components induced by them are represented diagrammatically in Fig 1, p 160. Fig 1a (top) shows the transverse component of the flux and the longitudinal component of the eddy current induced by it. Fig 1b indicates the longitudinal component of the flux and the transverse component of the current generated by it. In Fig 1 the currents are represented by toroids cut by the plane of the drawing which is imagined as being a vertical plane dividing the profile of the rail into two symmetrical halves. Polarities are assigned to the current components taking into consideration the directions and the character of the changes of the components of the flux in the respective parts of the railhead during movement of the source of the magnetic field. As was found experimentally, Ref 1, the transverse component of the current in the sections of the railhead located below the internal edge of the first pole of the electromagnet

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in the direction of movement exceeds the longitudinal component of the current. There is reason to assume that the same relation g o v e r n s the transverse and the longitudinal components of the current in other sections of the rail, particularly those located in the interpole space of the electromagnet. In Fig1B (bottom) a scheme is drawn of the eddy currents in the railhead taking this fact into consideration. It can be seen from Fig 1B that the direction of the eddy currents in the railhead depends on the location of the section relative to the electromagnet; the eddy currents in the sections located between the poles of the electromagnet have the same direction. The correctness of this was confirmed by measurements of the magnetic flux in the railhead (Ref 3) and of the longitudinal component of the potential of the electric field at the surface of the railhead (Ref 2). The eddy currents decrease in the direction from the first pole of the electromagnet (in

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the direction of movement) to the second (Ref 3), and finally there is a change in the direction of the current in the neighbourhood of the second pole. The directions of the eddy currents in the sections of the railhead located in the space between the poles of the electromagnet are favourable for detecting longitudinal cracks but they are less favourable for detecting transverse cracks. There are 1 figure and 3 references.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics, Ac. Sc., USSR)

SUBMITTED: October 31, 1957

(Note: This is a complete translation except for the figure captions)

USCOMM-DC-60,774

12(3), 25(6), 32(3) SOV/126-7-2-5/39

AUTHOR: Vlasov, V. V.

TITLE: Investigation Relating to the Defectoscopy of Railroad Rails in Mobile Magnetic Fields. Part 9. On the Role of Eddy Currents in the Formation of the Field Produced by a Defect (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh. 9. O roli vikhrevykh tokov v formirovanii polya defekta)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1959, Vol 7, Nr 2, pp 186-191 (USSR)

ABSTRACT: Part 10 of this paper,"Study of the magnetic flux in the railhead in the case of differing air gaps in the magnetic circuit",is published on pp 319-320 of this issue. In earlier parts of this paper (Refs 1-5) the author studied the electromagnetic phenomena occurring in the case of movement of the source of a magnetic field along a model of a rail which is free of defects. The problem of detecting artificially produced longitudinal and transverse defects and the shape of the e.m.f. pulses induced in the search coil when the source of the magnetic field and the magnetised component move

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Investigation Relating to the Defectoscopy of Railroad Rails in Mobile Magnetic Fields. Part 9. On the Role of Eddy Currents in the Formation of the Field Produced by a Defect

relative to each other was investigated in earlier published work of Khalileyev and the author of this paper (Refs 6, 7). The author considered it of interest to study the degree of participation of eddy currents, induced by the mobile magnetic field, in the formation of the defect field. In some cases it is not important to achieve geometric similarity of the defects in models. N. N. Zatsepin (Ref 8) has shown that in simulating on models the magnetostatic field of surface cracks it is not necessary to adhere accurately to strict geometrical similarity. According to Sapozhnikov (Ref 9) the same applies to the simulation on models of the flow of direct currents around cracks. However, as regards eddy currents, it has so far not been determined to what extent geometrical similarity of the defects must be adhered to. In view of the fact that in the model experiments the source of the magnetic field and the body magnetised by it were in relative motion, it was considered necessary

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that the artificial defects should be near in shape and dimensions to the real defects. In the here described work the author studied one of the components of the field of the defect by means of the e.m.f. generated in the search coil during its passage above the defective section, simultaneously with the magnetising coil. The artificially produced defects (slots) are shown in the drawing, Fig 1, p 187. On the basis of the obtained results it is concluded that the formation of the e.m.f. pulses is caused not only by the field of the defect which brings about the magnetization of the component, but also by the field of the eddy currents induced in the components during their magnetization by the moving source of the field. A critical speed was established below which the defects are detected on the basis of magnetization of the components, whilst above this speed they are detected on the basis of the eddy currents. An approximate evaluation is given of this critical speed as a function of the external e.m.f. for artificial

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defects of the type of a transverse crack in railheads. Fig 3 shows an oscillogram of pulses produced by a field source moving at a speed of 16 km/hr relative to the rails. Fig 4 shows an oscillogram pertaining to the same rail for a speed of movement of 40 km/hr. The dependence of the critical speed for a defect simulating a transverse crack in the railhead on the external e.m.f. is graphed in Fig 6; this graph was determined on the basis of the relation expressed by Eq (2).
There are 6 figures and 11 Soviet references.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics, Ac.Sc., USSR)

SUBMITTED: November 30, 1957

12(3), 25(6), 32(3) SOV/126-7-2-39/39

AUTHOR: Vlasov, V. V.

TITLE: Investigation Relating to the Defectoscopy of Railroad Rails in Mobile Magnetic Fields. Part 10. Study of the Magnetic Flux in the Railhead in the Case of Differing Air Gaps in the Magnetic Circuit (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh. 10. Izucheniye magnitnogo potoka v golovke rel'sa pri razlichnom vozdushnom zazore v magnitnoy tsepi)

PERIODICAL: Fizika Metallov i Metallovedeniye, 1959, Vol 7, Nr 2, pp 319-320 (USSR)

ABSTRACT: The magnetization of ferromagnetic bodies located in an open magnetic circuit differs from that pertaining to closed magnetic circuits. The problem of magnetization of a ferromagnetic in a circuit containing an air gap was investigated grapho-analytically by V. K. Arkad'yev (Ref 1), and experimentally on rings with a slot by V. V. Volkov (Ref 2); F. F. Panasenkov (Ref 3) investigated the magnetization of rods and rails by means of a Π-shaped electromagnet being placed on them. These investigations showed that the difference between the magnetization corresponding to the

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apex of the hysteresis loop and the residual magnetization of the body has a maximum for a certain air gap if the field does not drop below a certain value. The distance between the pole of the electromagnet and the rail during magnetization of the latter under conditions of motion has a similar influence on the magnetic flux in the rail. The author considered it of interest to investigate this point and for this purpose he studied the longitudinal component of the magnetic flux in the railhead by means of an analogue (Refs 4 and 5). Study of the longitudinal component of the magnetic flux in the railhead under conditions of movement and various magnitudes of the air gap between the poles of the electromagnet and the rail were carried out on a test-rig described in earlier work (Ref 6). For this purpose a Π-shaped electromagnet was used, the end pieces of which were flat at the side of the model rail. The investigations consisted in oscillographic

 recording of the longitudinal component of the magnetic

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flux produced as a result of integration of the e.m.f. in the coil surrounding the head of the rail analogue. The technique of investigation of the magnetic flux was the same as described in earlier work of the author (Ref 6). During the investigations the electromagnet was placed in a position such as to obtain "longitudinal" magnetization of the rail analogue. The movement of the rail analogue corresponded to the movement of a similar electromagnet relative to the rail with a speed of 45 km/hr. The external magnetizing ampere turns as well as the air gap were varied during the experiments. The magnitude of the magnetic flux was evaluated from the corresponding oscillograms for the section of the railhead located along the centre between the poles and the electromagnet. This means that determination of the magnetization in the railhead was effected during the time of passage of the respective section from the middle of the pole of the electromagnet (in the direction

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of movement) up to the middle of the distance between the poles of the electromagnet. The results of these investigations are graphed in Fig 1, which shows the dependence of the magnetic flux in the section of the railhead located in the centre between the poles of the electromagnet and the air gap between the pole and the rail at various magnetic field intensities. It can be seen from the graph that the longitudinal component of the magnetic flux in the railhead has a maximum for an air gap of a certain magnitude and not too high e.m.f. values. This appears most clearly from curve 2 relating to an m.m.f. of 10 000 ampere turns; the dependence of the flux of the air gap with increasing magnetizing ampere turns is less pronounced; in the case of 20 000 ampere turns (curve 4) it practically ceases. It is pointed out that in the case of a decrease in the m.m.f., for instance in the case of changing over from

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curve 2, the flux will decrease less in the case of an air gap between the pole of the electromagnet and the rail, d_1 = 20 mm (d = 5.5 mm for the rail analogue) than for an analogous change in the case of larger or smaller air gaps, for instance d_1 = 10.5 and 38.5 mm respectively. The dependence of the longitudinal component of the magnetic flux on the air gap in the case of relatively small magnitudes of the external mobile field is in agreement with the results obtained by investigation in static fields (Refs 2 and 3) and this is attributed to the demagnetizing effect of the surface of the ferromagnetic.
There are 1 figure and 6 Soviet references.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics, Ac.Sc. USSR)

SUBMITTED: November 30, 1957

(Note: This is a complete translation except for the figure caption)

USCOMM-DC-60,914

SOV/126-7-4-6/26

AUTHORS: Vlasov, V.V., Vorob'yev, A.I. and Uspenskiy, Ye.I.

TITLE: Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 13. Defectoscope for Testing Rails at High Speeds

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 7, Nr 4, pp 527-533 (USSR)

ABSTRACT: This is one of a long series of articles on the subject of detection of rail failures by means of magnetic fields moving at speeds which are acceptable in normal railroad operation. Increasing the speed of movement of the test apparatus is of considerable interest in tracks with high traffic densities. This problem has been relatively little studied. In earlier parts of this work (Ref 2 and 3), the theoretical and experimental fundamentals of rail defectoscopy in moving magnetic fields are described. Particularly, it is shown that it is possible to detect defects in rails at relatively high speeds of movement, of up to 90 km/hr. It was established that magnetization of the rails by moving sources induces in the rails relatively intensive eddy currents which participate in the formation of the

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defect field; the role of these currents is the more important the higher the speed of movement of the external magnetic field. The obtained results show that it is possible to utilise eddy currents induced in the rails by a moving magnetic field for rail defectoscopy purposes. Studying the shapes of the emf pulses induced in the search coil by dangerous and non-dangerous rail defects and by metallic components of the track structure enabled relatively satisfactory solution of the problem of separating out useful signals. This enabled the introduction of considerable changes in the practice of testing rails by means of moving magnetic fields. In this paper the design is described of apparatus fitted in an ordinary passenger wagon and intended for detecting defects in the track rails. The here described defectoscopy apparatus was built in 1952 (Ref 4 and 5) by modifying a relatively older type defectoscope wagon (Ref 6) which operated at a speed of 30 to 35 km/hr. The basic circuit is shown in Fig 1 and

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in general its conception is not original. The search equipment consists of a coil which is located in the middle between the poles of an electromagnet, the plane of the windings of which is perpendicular to the longitudinal rail axis. The coil is fitted on a 0.5 mm thick sledge of non-magnetic stainless steel. The emf induced in the search coil is recorded on a 35 mm film from an oscillograph; one cassette contains up to 300 m of film; the film consumption is about 5 m per kilometre of track, recording the signals from both rails of the track. The power supply is from a current type rail dynamo. The here described defectoscope wagon enables detecting defects in rails irrespective of weather and it can travel with a speed of up to 90 km/hr. Defectoscopes described by A.A.Kosarev (Ref 8) and others (Ref 9) operate at a running speed of 55 km/hr. The defectoscope wagon detected satisfactorily the following defects: relatively highly developed shallow transverse cracks in the railheads; relatively small

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transverse cracks in the railhead located on one side of the vertical axis of the rail at relatively small depths; relatively developed transverse cracks in welded joints and also cracks which extend from the foot to the head of the rail and transverse rail cracks; longitudinal-horizontal layering of the railheads; longitudinal-transverse cracks (as shown in the photo, Fig 5) and more complicated defects (shown in Fig 6). If the here described defectoscope is used, additional inspection can be reduced to a minimum. Some information is given about its characteristics and sensitivity. There are 8 figures, 1 table and 14 references, 12 of which are Soviet, 1 German and 1 English.

n.b. In part 14 of this series (pp 689-693, Vol 7, Nr 5) the substitution of the cinefilm recording by a magnetic tape recording is described and this is stated to be considerably more satisfactory.

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Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 13. Defectoscope for Testing Rails at High Speeds

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics, AS USSR)

SUBMITTED: December 19, 1958

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SOV/126- -7-5-9/25

AUTHORS: Vlasov, V.V., Subbotin, Yu.S. and Babushkin, V.I.

TITLE: Investigations Relating to Defectoscopy of Railroad Rails in Moving Magnetic Fields. 14. On Applying a Magnetic Memory in the Defect Checking of Rails (Issledovaniya po defektoskopii zheleznodorozhnykh rel'sov v dvizhushchikhsya magnitnykh polyakh. 14. O primenenii magnitnoy pamyati pri kontrole rel'sov)

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 7, Nr 5, pp 689-693 (USSR)

ABSTRACT: This is one of a long series of articles on the subject of detection of rail failures by means of magnetic fields moving at speeds which are acceptable in normal railroad operation. In the case of a speed of 45 km/hr, the rail test truck travels a distance of 12.6 m in one sec; and in the case of travelling at a speed of 90 km/hr it traverses the same distance in half a second. In the given cases the duration of the signals produced by transverse cracks in the railheads are 4 and 2 msec respectively. During that time it is necessary to record not only the presence of an electromagnetic disturbance above the defective parts of the rail but it is also necessary to determine its character, i.e. the

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Investigations Relating to Defectoscopy of Railroad Rails in Moving Magnetic Fields. 14. On Applying a Magnetic Memory in the Defect Checking of Rails

shape of the e.m.f. induced in the search equipment of the defectoscope. At present such defectoscope equipped vehicles are fitted with an optical method of recording signals from the defects onto a normal negative cinefilm. The authors propose to substitute this by recording on a magnetic tape. The block schematics of the recording circuit are shown in Fig 1. A single 6.35 mm wide tape is used for recording the signals induced by both rails of the track. The kilometre markings are produced by changing the amplitudes of the signals by means of plates placed onto the sleepers. A schematic diagram of the signal reproduction mechanism is shown in Fig 5. Experiments have shown that the signals produced by defects of rails and also by other metallic components of the truck can be satisfactorily detected from the magnetic tape recordings. Any part of the recording can be analysed in detail by keeping the tape still relative to the rotating disc carrying the reproduction heads. If the tape moves at a certain speed relative to these

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rotating reproduction heads, the signals recorded can be read off. The tape recordings allow easy amplification of the e.m.f. curves in amplitude as well as in time. The first is achieved by controlling the amplification, the second by increasing the scanning speed. Consequently, the magnetic tape is a considerably more flexible tool for detecting rail defects than cinefilm recordings.

Card 3/3 There are 5 figures and 7 references, 5 of which are Soviet, 1 English and 1 International.

ASSOCIATION: Institut fiziki metallov AN SSSR
(Institute of Metal Physics, Ac.Sc. USSR)

SUBMITTED: August 12, 1958

AUTHORS: Vlasov, V.V. and Ushakova, G. G. SOV/126-7-6-5/24

TITLE: Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 15. Spectra of Signals from Certain Defects

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 7, Nr 6, pp 837-841 (USSR)

ABSTRACT: This is one of a long series of articles on the subject of detection of rail failures by means of magnetic fields moving at speeds which are acceptable in normal railroad operation.
The spectral composition of signals produced during high-speed defectoscopy of rails has so far not been studied. The authors investigated experimentally the spectral composition of three types of signals which occur most frequently in rail defectoscopy and are produced by transverse and longitudinal cracks in the railhead. Since the signals produced by the defects consist of non-periodic pulses, it is difficult to determine their spectral composition by currently used experimental techniques. However, spectra of non-periodic pulses can be studied by periodic repetition of the investigated pulse

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Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 15. Spectra of Signals from Certain Defects

shape. This substitution is based on the relation between the spectrum of the individual pulse and the spectrum of periodic sequence of such pulses, dealt with in the book "Spectra and Spectrum Analysis" by A. A. Kharkevich (Moscow, 1953). The mathematical analysis of this relation is briefly discussed and it is shown that the curve of the continuous spectrum represents the geometrical loci of points TA_k characterizing the line spectrum of a periodic sequence of pulses formed by repeating the pulse under investigation. Investigations were carried out by means of a model described in earlier parts of this series of articles (Refs 5 and 6). A diagram of the experimental rig is shown in Fig 1. It consists of a circular model of the rail which rotates under a d.c. fed electromagnet. The investigated defects were produced artificially by transverse filing of the rail model as described in an earlier paper of this series (Ref 2). To separate the studied pulse from those produced by other defects a simple switching device was used, by means of which the amplifier was short-circuited during passage under the

Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 15. Spectra of Signals from Certain Defects

electromagnet of all the defects except the one actually studied. Oscillograms of the pulses produced by transverse cracks in the railhead are reproduced in Fig 2, the spectra of the signals are reproduced in Fig 3. It is concluded that the frequencies corresponding to the maximum spectral density of the pulses produced by the defects are practically equal, for a given speed of movement of the defectoscope, irrespective of the differences in the shape of the pulses produced by the defects. With increasing speed of movement of the defectoscope, the spectrum of the pulse will change, the maximum spectral density will shift towards higher frequencies and the entire spectrum will become blurred as a result of an increase in the high frequency components of the spectrum.

There are 3 figures and 9 references, 8 of which are Soviet and 1 English.

ASSOCIATION: Institut fiziki metallov AN SSSR (Institute of Metal Physics, Ac.Sc., USSR)

SUBMITTED: February 26, 1959

SOV/126-7-6-22/24

AUTHORS: Vlasov, V.V. and Korobkova, L.I.

TITLE: Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 16. Study of the Possibility of Detecting Defects from Their Reaction on the Primary Field

PERIODICAL: Fizika metallov i metallovedeniye, 1959, Vol 7, Nr 6, pp 937-939 (USSR)

ABSTRACT: This is one of a long series of articles on the subject of detection of rail failures by means of magnetic fields moving at speeds which are acceptable in normal railroad operation.
At present the wagon which carries the defectoscopy apparatus is pulled by means of a separate locomotive. However, it would be useful to be able to attach the defectoscopy wagon to any train. This would be possible only if the test apparatus were not less than 100 mm above the rails, which requires increasing the air gap between the electromagnet and the rail from 10-30 mm to 100 mm and to lift to the same level the search equipment. This obviously leads to a considerable drop in the sensitivity of the defectoscope. The authors considered

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Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 16. Study of the Possibility of Detecting Defects from Their Reaction on the Primary Field

it of interest to study the possibility of detecting defects from their reaction on the primary field and particularly from the disturbance of the magnetic flux in the core of the magnetizing electromagnet. Therefore, they studied the possibility of detecting an artificial defect of the type of a transverse crack in the railhead for various vertical distances from the rail to the electromagnet, which is used for generating the magnetic field above the rail, the search coil being located directly on the core of the electromagnet. The investigations were carried out by using a model, dealt with in earlier parts of this series of articles, Refs 2 and 3. A diagrammatic sketch of the model is shown in Fig 1. For magnetizing the rail model, an electromagnet was used with a core made of 0.35 mm thick transformer sheet (30 mm wide, with a packet width of 20 mm). The experiments revealed that, at least

 extensively developed defects, can be detected in rails

Investigations Relating to the Defectoscopy of Railroad Rails in Moving Magnetic Fields. 16. Study of the Possibility of Detecting Defects from Their Reaction on the Primary Field

by means of an electromagnet located 100 mm above the rail and that the defects can be detected more easily by means of a coil located on the second (trailing) pole in the direction of movement than on the first pole (pole S of Fig 1). The authors recommend that for solving the problem the carried out laboratory experiments should be supplemented by experiments on normal tracks.
There are 3 figures and 3 Soviet references.

ASSOCIATION: Institut fiziki metallov AN SSSR
(Institute of Metal Physics, Ac.Sc. USSR)

SUBMITTED: April 7, 1958

18.8400

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SOV/126-8-5-7/29

AUTHORS: Vlasov, V.V., and Yershov, R.Ye.

TITLE: On the Dependence of a Crack-type Defect Field on the Thickness of the Metal Layer Covering It

PERIODICAL: Fizika metallov i metallovedeniye, Vol 8, 1959, Nr 5, pp 689-693 (USSR)

ABSTRACT: On the basis of an experimental and theoretical investigation of the dependence of the field of a cylindrical defect on its depth of location, A.P. Sapozhnikov (Ref 2) concluded that the leakage field is caused not only by the walls of the defect but also by the metal located above it. Therefore, with decreasing thickness of the layer above the defect, the intensity of the defect field should increase, but only until the defect zone of the metal is directly affected. In the case of an open defect, such a zone is completely absent and the defect field can be smaller still. To verify this result, the authors studied artificial defects which were covered with magnetically differing layers (Refs 7,8,9). The main drawback of these earlier experiments was that the defect was covered by a separate piece of metal. In the present paper

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On the Dependence of a Crack-type Defect Field on the Thickness of the Metal Layer Covering It

experiments are described with strongly work-hardened 1% Si-steel plates 120 x 80 x 9 mm. In these, the defect (25 x 1.3 mm) simulating the transverse crack was located in the centre of the plate (Fig 1) with its length in the transverse direction and its breadth (1.3 mm) in the direction of the longitudinal axis. The plate was placed between the poles of an electromagnet. The dependence of the tangential component of the defect field H on the induction B in the plate for thicknesses of the material above the defect of 0, 2.5, 7.4 and 28.3 mm, is plotted in Fig 3. Fig 4 shows similar curves for a defect breadth of 0.24 mm in the absence of any material above the defect, and in the presence of a 1.5 mm thick layer. Further data are plotted in Fig 5. The experiments have shown that the magnetostatic field of a crack-type defect increases with decreasing thickness of the covering layer, which is in agreement with the data in the literature for the field of a cylindrical defect. The divergent results obtained in earlier work of one of the present authors [4]

On the Dependence of a Crack-type Defect Field on the Thickness of the Metal Layer Covering It

(Refs 7, 8) appear to be due to experimental errors.
Acknowledgements are expressed to Professor R.I. Yanus for his critical comments.
There are 5 figures and 9 Soviet references.

ASSOCIATION: Institut fiziki metallov AN SSSR
(Institute of Physics of Metals, Academy of Sciences, USSR)

SUBMITTED: March 31, 1959

Card 3/3

VLASOV, V. V., Doc Tech Sci -- "Rapid electromagnetic defectoscopy of railroad rails." Tomsk, 1961. (Min of Higher and Sec Spec Ed RSFSR. Tomsk Order of Labor Red Banner Polytech Inst im S. M. Kirov). (KL, 8-61, 239)

S/755/61/000/003/009/027

AUTHORS: Bychkov, Yu. F., Vlasov, V. V., Rozanov, A. N.

TITLE: Some properties of ternary β solid solutions of zirconium with niobium and molybdenum.

SOURCE: Moscow. Inzhenerno-fizicheskiy institut. Metallurgiya i metallove-deniye chistykh metallov. no.3. 1961, 82-95.

TEXT: The paper provides a literature survey and a report on an experimental investigation on certain alloys of the Zr-Nb-Mo which exhibit a highly stable β solid solution and which have good over-all mechanical properties, good heat resistance, forgeability, and refractoriness. The literature survey is largely based on "The metallurgy of zirconium" (B. Lustman, F. Kerze, Jr., eds., McGraw-Hill, 1955; Foreign Lit. Publ. House, Moscow, 1959), the contribution of O. Ivanov, and V. K. Grigorovich at the 2d Internat'l Conf. on the Peaceful Uses of Atomic Energy, Geneva, 1958, a paper by Yu. F. Bychkov, et al., (Atomnaya energiya, v.2, no.2, 1957, 146), Domogala, R. F., et al. (J. Metals, v.9, no.10, sec. II, 1957, 1191-6). The especial objective of the present investigation was the study of the ternary β solid solutions of Zr with Nb and Mo in that region of the phase diagram in which such solid solutions could be expected to exist to form refractory alloys.

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The partial replacement of Nb by Mo is of especial interest since a given Mo addition is twice as effective in stabilizing the β phase (O. Ivanov, loc. cit.). The preparation of the alloys in an arc furnace in an atmosphere of chemically pure Ar, purified by a Zr getter melt, is described; the alloy composition is summarized in a half-page table. Corrosion tests were made on 10-mm diam, 6-mm high, cylindrical specimens prepared from 8-10-time remelted 20-25-g powder batches, which were surface-ground and acetone-washed. Mechanical tests were performed on 80-90-mm long rods weighing 65-70 g; elongation-test specimens were 3 mm diam, 20 mm long. Heating for hardness tests was performed at 5°C/min, with 3-min hold at test T and a one-minute diamond-pyramid impression under a 1-kg load. The m.p. was measured pyrometrically by observing the interior of a small aperture in the specimen up to the moment of the filling-in of the aperture. The modulus of normal elasticity was measured by means of the flexural resonance frequency of a freely suspended cast rod on the vacuum equipment described by the senior author, et al. (in Atomnaya energiya, v.2, no.2, 1957, 152) an equipment which was also employed for resistance measurements by means of a twin bridged-T type Thomson network. A vacuum dilatometer was used in the elongation measurements. The refractoriness of the various alloys was tested by 125-hr air oxidation at 600°C. The most refractory of the alloys tested was found to be the alloy with 15% Nb and 10% Mo. Small (0.1-0.5%) additions of Fe, Ni, Cu, and Ag increased the refractoriness of all

Some properties of ternary β solid solutions ... S/755/61/000/003/009/027

Zr-Nb-Mo alloys substantially. The kinetics of the oxidation comprise a low-rate first stage, in which a black, tightly-adhering, oxide film is formed, and a more steeply rising second stage, in which a grey oxide forms on the edges of the specimens. The black film on the heat-resistant alloys was studied by X-ray diffraction and was found to contain not only ZrO_2 (as on pure Zr), but a small quantity of compounds such as $Nb_2O_5 \cdot 6ZrO_2$ (cf. Spitsyn, V. I., et al., Akad. n. SSSR. Dokl., v.131, no.4, 1960, 858, and Klopp, W. D., et al., Report no.712 at the 2d Internat'l Conf. on the Peaceful Uses of Atomic Energy, Geneva, 1958). The mechanical tests (H_R $_C$ of a 50% deformed specimen versus T upon 30-min hold) show that the β solid solution in the optimal alloy has significant stability, but is not thermodynamically stable and decomposes at high T with the formation of a second phase. The heat resistance of the alloys was tested by H_V and stress-rupture tests at various T. The H_V of most of the alloys dropped rapidly beyond 500°C (except for the 750°C break of the 48% Ni, 3% Ti alloy recommended in Nucl. Sci. Abstracts, v.28, no.2232, 1959). Alloys of the 15Nb-10Mo type have about the same H_V at 680°C as Zircalloy-2 has at 300°C. The high heat resistance of β solid solutions of Zr is in consonance with the findings set forth in D. Douglass's brief communication in Reactor Core Materials, Aug. 1960, 44. The physical properties of the 15Nb-10 Mo alloy were further investigated. Its m.p. is 1,640°C; with the addition of 0.5% each

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of Fe, Cu, Ni, and Ag its m.p. is 1,525°C. E at room T is 8,600 kg/mm^2, i.e., less than that of Zr (10,800 kg/mm^2), but at 900°C the E of the alloy is 6,750 against that of Zr which is 3,420 kg/mm^2. The linear expansion coefficient is small ($6.5 \cdot 10^{-6}$/°C) and almost T-independent in the 100-800°C range. The calculated heat-conductivity coefficient at 500°C of the alloy is somewhat higher than that of Zr (0.2 against 0.16 w/cm·°C. There are 7 figures, 3 tables, and 14 references (6 Russian-language Soviet, 2 Russian-language translations of English-language originals, and 6 English-language).

ASSOCIATION: MIFI (Moscow Engineering Physics Institute).

BUZDOV, K.A.; VLASOV, V.V.

Nature of the products obtained in the thermal dissociation of solid solutions of iron and manganese carbonates. Zhur.neorg. khim. 8 no.1:160-162 Ja '63. (MIRA 16:5)
(Carbonates) (Solutions, Solid)

BORISOVA, L.A.; YEFREMOVA, M.V.; VLASOV, V.V.

Phase diagram of the system Tl_2Te_3 - Bi_2Te_3 and properties of the alloys obtained. Dokl.AN SSSR 149 no.1:117-119 Mr '63. (MIRA 16:2)

1. Khimicheskiy institut im. A.Ye.Arbuzova AN SSSR. Predstavleno akademikom A.Ye.Arbuzovym.

(Thallium-tellurium-bismuth alloys--Thermal properties)

AID Nr. 986-4 10 June

DIFFERENTIAL THERMOPILES (USSR)

Vlasov, V. V. Priborostroyeniye, no. 4, Apr 1963, 27-28.
S/119/63/000/004/009/010

Chromel-copel thermopiles, developed by the author for temperature measurements, consisting of 2 to 50 series-connected thermocouples have been investigated to determine the dependence of their thermal emf on time during heating and cooling in air and in transformer oil. The experiments have confirmed that with the transfer of the pickups from a heated to a cool medium — or vice versa — their thermal emf increases to a maximum and then decreases. This makes it possible to utilize them as temperature signalizers which yield an electrical pulse at rapid temperature variations. Therefore, provided the conditions for the sinking of pickups in the heated or cooled medium, preferably liquid, are identical, it would be possible to measure the temperature of a medium on the basis of the thermal emf maximum of differential thermopiles. The method would be especially advantageous in the case of remote-control measurements.

[DW]

Card 1/1

L 38280-65 EWP(c)/EWP(k)/EWT(d)/EWT(m)/EWP(b)/T/EWA(d)/EWP(l)/EWP(w)/EWP(v)/EWP(t)
Pf-4 JD

SOURCE: Byulleten' izobreteniy i tovarnykh znakov, no. 5, 1965, 86

phase shift of the corresponding [illegible]

ASTAKHOV, A.G.; VLASOV, V.V.; GOLUBEV, A.I.; GRIMSENKO, P.I.; FEDOROVSKIY, N.V.

A system for the automatic control of fuel proportioning processes in sintering plants. Met. i gornorud. prom. no.4: 12-13 Jl-Ag '65. (MIRA 18:10)

ALABUZHEV, P.M.; VIASOV, V.V.

Analysis and synthesis of a piston-actuated air drive with application of a variable reduced external force. Fiz.-tekh. probl. razrab. pol. iskop. no.5:91-99 '65.

(MIRA 19:1)

1. Elektrotekhnicheskiy institut, Novosibirsk.

VLASOV, V.V., kand.med.nauk (Novosibirsk).

Hypertrichosis and hypotrichosis following thermal burns.
Vest. derm. i ven. no.5:66-68 '65.

(MIRA 18:11)

VLASOV, V. V.; KUZNETSOV, A. V.

Melanterite and the products of its alternation. Zap. Vses. min. ob-va 91 no.4:490-492 '62. (MIRA 15:10)

1. Kazanskiy filial AN SSSR.

(Tatar A.S.S.R.—Melanterite)
(Udmurt A.S.S.S.—Melanterite)

GORBACHEV, B.F.; SITDIKOV, B.S.; VLASOV, V.V.

Weathering crust on the crystalline rocks of the base of the northeastern part of the Tatar A.S.S.R. Dokl. AN SSSR 146 no.1:195-198 S '62. (MIRA 15:9)

1. Kazanskiy gosudarstvennyy universitet im. V.I. Ul'yanova-Lenina i Kazanskiy filial AN SSSR. Predstavleno akademikom N.M. Strakhovym.
(Tatar A.S.S.R.—Petrology)

VLASOV, V.V.

Mineralogical characteristics of phosphorite concretions in Devonian sediments in the southeast of Tatarstan and the adjacent regions in Kuybyshev Province. Rent.min.syr. no.3:147-150 '63. (MIRA 17:4)

1. Geologicheskiy institut Kazanskogo filiala AN SSSR.

VLASOV, V.V.; REMIZNIKOVA, V.I.

X-ray determination of kaolinite and some other clay minerals and layered silicates. Lit. i pol. iskop. no.2:177-180 Mr-Ap '65.
(MIRA 18:6)

1. Geologicheskiy institut Kazanskogo gosudarstvennogo universiteta.

LEVITSKIY, V.Ye.; VLASOV, V.V.

Iron- and phosphorus-bearing allophanoid from the Upper Jurassic sediments of Ul'yanovsk Province. Zap. Vses. min. ob-va. 94 no.4:465-468 '65. (MIRA 18:9)

1. Geologicheskiy institut Kazanskogo filiala AN SSSR.

KIRSANOV, N.V.; VLASOV, V.V.; SABITOV, A.A.

Mineralogical composition of bentonites in the Nurlat deposit of the Tatar A.S.S.R. Lit. i pol. iskop. no.3:96-104 My-Je '65. (MIRA 18:10)

1. Geologicheskiy institut, Kazan'.

VDOVIN, Yu.A.; VLASOV, V.V.; ZATSEPIN, N.N.; KOROBEYNIKOVA, I.Ye.; MIKHEYEV, M.N.; RODIGIN, N.M.; TOMILOV, G.S.; SHTURKIN, D.A.; YANUS, R.I.

Discussion on nondestructive testing methods. Defektoskopiia no.1:90 '65. (MIRA 18:6)

VLASOV, V.V., kand.fiz.-mat.nauk; SUBBOTIN, Yu.S.

New phase sensitive eddy current method of detecting surface cracks in metal products. Report No.1: Physical principles. Defektoskopiia 1 no.3:71-73 '65. (MIRA 18:8)

1. Institut fiziki metallov AN SSSR.

AUTHOR: [illegible]; Subbotin, Yu. S.

TITLE: New phase-sensitive eddy current method for the detection of surface cracks in metallic products. I. Physical basis

SOURCE: Defektoskopiya, no. 3, 1965, 71-77

TOPIC TAGS: phase-sensitive defectoscope, surface crack detection, eddy current defectoscope, defectoscope design

ABSTRACT: Existing eddy-current defectoscopes are insufficiently accurate [illegible] because of their insufficient sensitivity [illegible] relative to the various types of [illegible]

L 60126-65
ACCESSION NR: AP5018239

3

defects and perturbations. Special attention is paid to those peculiarities in the field near cracks which are caused by the topography of eddy currents [illegible]

[illegible] measuring instruments. The article describes the experimental methods for the study of magnitude and phase of the induced emf in detail and presents the results of such investigations. The results were used for the design of a new type of eddy current defectoscope described in the second part of [illegible]

[illegible]

AN SSSR

NO REF SOV: 002 OTHER: 001

Card 2/2

L 60127-65 EWT(d)/EWT(m)/EWP(w)/[illegible]

ACCESSION NR: AP5018246

AUTHOR: Vlasov, V. V.; Subbotin, Yu. S.

TITLE: New phase-sensitive eddy current method for the detection of surface cracks in metallic products. II.

TOPIC TAGS: phase-sensitive defectoscope, defectoscope design, eddy current defectoscope, crack detection

ABSTRACT: In the first part of this article, the authors showed that the magnitude and phase shift of [illegible] sample within the priming [illegible] phase shift of the emf induced by the crack. Both of these facts are utilized for the establishment of a new [illegible] scope. The present, second [illegible] explains how [illegible]

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ACCESSION NR: AP5018240

lists the various samples used and the order of testing of the prototype, presents the results of tests [illegible]

SUBMITTED: 15Feb65 ENCL: 01 SUB CODE: MM, IE

NO REF SOV: 002 OTHER: 000

Card 2/3

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ACCESSION NR: AP5018240

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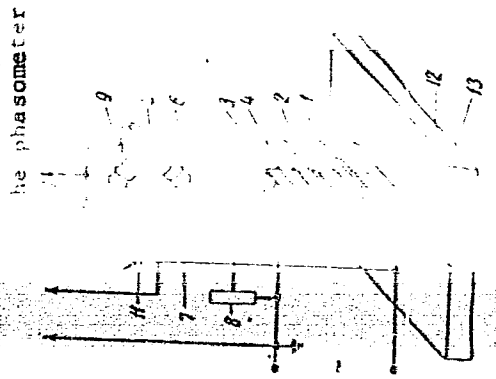

Fig. 1. Theoretical diagram of the defectoscope under discussion:
1 - ferromagnetic core, 2 - winding, 3 - ferromagnetic plate, 4 - winding
5 - transformer, 6 - main winding, [illegible] - output winding, 10 - [illegible]

BERG, L.G.; REMIZNIKOVA, V.I.; VLASOV, V.V.

Chemism of the interaction between kaolinite and sodium hydroxide. Izv.vys.ucheb.zav.; khim. i khim.tekh. 8 no.2:181-185 '65. (MIRA 18:8)

1. Kazanskiy gosudarstvennyy universitet imeni Ul'yanova-Lenina, kafedra neorganicheskoy khimii.

VLASOV, V.V., kand, med. nauk (Novosibirsk); BROKHES, L.I. (Novosibirsk); SHTERNSHIS, Yu.S. (Novosibirsk)

Effective anticoagulant treatment in thromboembolism of the pulmonary artery. Khirurgiia 40 no.11:121-122 N '65. (MIRA 18:7)

VLASOV, V.V., kand.med.nauk

Experience with the treatment of superficial burns. Vest. derm. i ven. 38 no.7:43-47 Jl '64. (MIRA 18:4)